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(11) (C) (CA) No. 919467

(45) ISSUED Jan. 23, 1973

(52) CLASS 92-12
C.R. CL. 92-64

(10) CANADIAN PATENT

(54) PATTERNED PAPER WITH SIMULATED WOVEN STRUCTURE

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(21) APPLICATION No. 099,720
(22) FILED Dec. 3, 1970

(30) PRIORITY DATE July 6, 1970 (45-58382) Japan

No. OF CLAIMS 10

This invention relates to a process for producing patterned paper with simulated woven structure constituted by a self-bonding force and to patterned paper produced thereby. More particularly, it relates to a new patterning process and a paper product which is manufactured from incompletely regenerated viscose fibers, the primary swelling value of which is in a range of from 800 to 10,000%. The patterning is applied to a wet paper sheet when its water-containing value is in a range of from 600 to 6,000%.

The process of the present invention is a patterning process employed in a paper making process. In this invention, two typical patterning methods are used, to provide paper of improved characteristics.

The method used for determining the primary swelling value (PSV) of incompletely regenerated cellulose filaments is as follows: the filaments of ca 9.5 grams (as a bone-dry sample) are weighted (W_D) and then steeped in distilled water at 20°C for 5 min. The swollen filaments thus obtained are centrifuged for 3 min. by a froce of 1,000G and the weight (w) of the hydroextracted filaments is obtained. The primary swelling value is calculated from the following formula:

$$W/W_D \times 100\ (\%) = \text{primary swelling value.}$$

The water-containing value (WV) of a wet paper sheet is determined as follows: a wet sheet of ca 5 grams is weighed (w^1) and then steeped in 3 g/l sulphuric acid solution for 1 min. at 90-100°C. It is then thoroughly washed and dried and the weight (W_D^1) thereafter is obtained. The WV is calculated from the following formula:

$$W^1 / W_D^1 \times 100\ (\%) = \text{water-containing value.}$$

A process, wherein a paper product is manufactured from incompletely regenerated viscose fibers, the PSV of which is in

a range of from 800 to 10,000, is described in U.S. Patent No. 3,320,117. Additional prior teachings on this subject of the manufacture of patterned paper may be derived from United States Patents Nos. 2,771,363; 3,240,657; 3,081,514 and 3,081,515.

One process of the present invention uses press-rolls on the surface of which a number of projections are arranged in a predetermined pattern. Thus, a wet paper sheet is patterned by passing through these press-rolls. Similarly, as another patterning process, a plate, on the surface of which a number of projections are arranged in a predetermined pattern, may be used. In this case, a wet paper sheet is passed through the press-rolls with the plate laid on one side of the sheet. The roll or the plate with the projections is made of a metal or of a hard material.

Another method of the present invention employs a metal plate or a hard plate, on which a number of holes arranged in a predetermined pattern are punched, is used as a patterning means. A wet paper sheet is patterned by passing through the press-rolls, one of which is wound round with the said punched plate, or patterned by passing through the press-rolls together with the punched plate laid on one side of the sheet. In this case also, the punched plate is made of a metal or of a hard material.

A wire net may be used as the patterning apparatus. A wet sheet is passed through a set of rolls together with the wire net. Then a pattern of the wire net is imparted to the wet sheet. In this case, the knuckles of the wire net correspond to the pressed areas and the meshes of the wire net to the non-pressed areas. As the result, the finished product differentiates into three portions.

The patterned paper hereby produced is constituted by a self-bonding force. More particularly, there is provided a new paper product which is manufactured from incompletely regenerated

viscose fibers patterned by using special patterning apparatus. This invention thus provides a modified paper making process for low-priced paper having not only the superficial appearance and hand of a woven texture, but having also high strenght, especially high wet strength.

The product of this invention is obtained as follows. By spinning a viscose having a high viscosity and a high γ-value into a low acid concentration bath, incompletely regenerated cellulose filaments, the primary swelling value of which is in the range of from 800 to 10,000%, are obtained. After cutting the filaments and dispersing them into water, a stock solution is obtained. By feeding the stock solution to a paper making machine, a wet paper sheet is formed. The wet sheet thus obtained is pressed locally with a patterning apparatus when the water-containing value of the sheet is in the range of from 600 to 6,000%. Thereafter the patterned sheet is transferred to the after-treatment section, i.e. complete regeneration of cellulose, desulphurization, bleaching and washing. Finally, the wet sheet is transferred to the drying section.

The product of this invention has the following three special features. The first feature is that the product consists of three portions having different thicknesses and density. Such differentiation of thickness or density results from the local compression of the wet sheet when its WV is in the range of from 600 to 6,000%. By such compression, a part or a greater part of the fibers in the pressed areas moves to the non-pressed areas in the close vicinity of the pressed areas. As the results, the pressed areas (first portion) become thinner or foraminous, indicating the highest density (except foramen-case). On the other hand, the non-pressed areas (second portion) in the close vicinity

of the pressed areas become thicker indicating a higher density. Furthermore, there exist areas (third portion) having the original thickness and density not affected by the compression (third portion).

As a special case, there exists a paper sheet consisting of only first and second portions, lacking the third portion as described below.

The second feature is that the product possesses a rugged pattern. The thinner areas (first portion) make indentations and thicker areas (second portion) as well as the areas having the original thickness (third portion) produce projections in the plane facing the patterning apparatus.

The third feature is that individual fibers constituting the product are connected chemically to each other with a self-bonding force. A wet paper sheet after patterning still consists of incompletely regenerated cellulose fibers, and accordingly, in the regeneration bath, the hydrogen-bonds are formed between adjacent fibers during the complete regeneration process. As the result, the paper sheet has high tenacity, especially high wet tenacity. In this point, the paper sheet of this invention is utterly different from regular paper products or the like which are produced by the interwining property of fibrils of the individual fibers, or from nonwoven textiles or rayon papers which are constituted by the bonding force of the binding materials incorporated between the fibers.

A better understanding of the invention may be had from the following description read in conjunction with the accompanying drawings, wherein

Fig. 1 is a partial plan view of a punched plate,

Fig. 2 is a cross section taken along the line A-A' in Fig. 1,

Fig. 3 is a partial plan view of another punched plate,

Fig. 4 is a cross section taken along the line B-B' in Fig. 3,

Fig. 5 is a partial plan view of another punched plate,

Fig. 6 is a cross section taken along the line C-C' in Fig. 5,

Fig. 7 is a partial plan view of a roll with projections,

Fig. 8 is a cross section taken along the line D-D' in Fig. 7,

Fig. 9 is a partial plan view of a patterning wire net,

Fig. 10 is a cross section taken along the line A"-A" in Fig. 9,

Fig. 11 is a partial plan view of a paper sheet made by using a patterning net,

Fig. 12 is a cross section taken along the line B"-B" in Fig. 11,

Fig. 13 is a partial plan view of a patterning roll with a plurality of projections,

Fig. 14 is a cross section taken along the line C"-C" in Fig. 13,

Fig. 15 is a partial cross section of a paper sheet made by using a patterning roll,

Fig. 16 is a partial cross section of a paper sheet made by using a punched plate as a patterning apparatus, as in Figs. 1, 3 or 5.

By the aforesaid patterning, both pliability and elasticity are given to the product, and the product has the simulated appearance and hand of a woven fabric. On the other hand, the production cost of the material is cheap, because,in the

present invention, cellulose is used as a starting material and furthermore no binder is necessary. Accordingly, for the actual use of the product there may be many cases, e.g. as a disposable-use, a top sheet cover for a baby diaper or a sanitary napkin, a bed sheet for hotels or hospitals, a hospital gown or medical supplies, etc.

By such compression, a part of fibers in the pressed areas moves to the non-pressed areas, and a pattern consisting of different thicknesses, i.e., a shaded pattern is obtained. In the present case, a clear shaded pattern is imparted to a paper product, while in other processes a rugged pattern is a principal feature. The higher the compression, the more differentiation in thickness across the product results. The press-weight of the compression is generally chosen in a range of from 10 to 20 kg/cm, although it should be adjusted in accordance with the WV of the wet sheet, the PSV of the material fibers or the shape,dimension of the pattern, etc.

In the process of the present invention, the patterning is carried out when the WV of the wet sheet is between 600 and 6,000%. It is of no effect to press the wet sheet when the WV of the sheet is less than 600%. On the other hand, when the WV of the sheet is more than 6,000%, the wet sheet is apt to flow and the processing becomes very difficult. In this case, the press-effect itself is insufficient if the press-weight is reduced so as to stop the flow of the wet sheet.

A paper product made by the patterning means having projections differs significantly in its appearance from that made by the patterning means with the punched holes. In the former, the pressed areas are distributed in the matrix consisting of the non-pressed area, while, in the latter, the non-pressed areas are

distributed in the matrix consisting of the pressed area.

In the present invention, the fibers, the PSV of which is from 800 to 10,000% and the WV of which is from 600 to 6,000%, combine tightly with each other and constitute a fairly strong wet sheet. In such a case, the fibers in the sheet can be moved easily by mere compression on account of their rheological properties derived from their high PSV or WV-value and thus the clear patterns are obtainable by the above-mentioned patterning system. The pattern thus obtained is finally consolidated in the wet sheet during the subsequent regeneration treatment and remain as it is in the finished product, the fibers being substantially in a random array, not parallel, and not in yarn-like groups. Furthermore, the component fibers are connected chemically to each other by a self-bonding force.

For the present patterning process it is easy to change the pattern in accordance with the use of the product. For instance, in case of the patterning by the press-roll with projections, various products are obtainable by changing the shape and the dimension of a projection or numbers of the projections per unit area, etc. Furthermore, it is possible to impart the patterns of various shapes as a combination to the product.

By the aforesaid patterning, both pliability and elasticity are given to the products, and they are characterized by the simulated appearance and hand of a woven fabric. For the actual use of these products, there may be many cases; e.g. as a disposable-use, a top sheet cover for a baby diaper or a sanitary napkin, a bed sheet for hospitals or hotels, a hospital gown, or medical supplies, etc.

The following Example illustrates the invention.

Example:-

Incompletely regenerated filaments with the PSV of

3,500% were obtained by spinning a high-viscosity viscose having highly polymerized cellulose into a low acid concentration bath. After cutting the filaments and dispersing them in water, five sheets of wet paper were made by a paper machine. Three sheets of them were patterned by passing them through a set of the press-rolls together with punched metal plates, one side of which naturally pressed against the sheets, as shown in Figs. 1, 3, 5, and another sheet was patterned by passing through a set of the press-rolls, one of which possesses a number of projections on its surface as shown in Fig. 7. Those patterned paper sheets as well as the remaining non-patterned sheet were completely regenerated, desulphurized, bleached and dried, and four kinds of patterned paper sheets and a non-patterned sheet were obtained. The characteristics of those patterned paper sheets are shown in the following Table in comparison with the non-patterned paper sheet.

TABLE

No. of Figure	Weight (g/m^2)	Breaking (KM) Strength (machine direction)	Softness
non-patterned	47.9	1.14	6.2
1	46.3	1.44	4.8
2	45.5	1.29	3.7
3	47.2	1.57	5.0
4	46.1	1.35	3.3

It is clear that by the application of the present invention, both the breaking strength and the softness of the paper sheets have been improved.

In defining the present invention, both as to method, and the product thereby produced, in relation to the aforementioned prior art, the following should be understood.

There are several products which impart a weave-like pattern to paper or nonwoven fabrics. For instance, in U.S. Patent No. 2,771,363, patterned paper is obtained by using a heavy wire large-mesh screen in a paper making machine. In the process of said invention, a part of fibers on knuckle areas of the screen moves to foraminous areas of the screen, and accordingly, a wet paper sheet is constituted by two portions, i.e. the thinner areas and the thicker areas. The said product is apparently similar to that of the present invention. However, in said product, the sheet is formed by the interfelted relation of the component fibers. That is to say, the sheet is constituted by the mechanical force. In this point the said product is utterly different from the product of the present invention, wherein the component fibers are connected chemically to each other by a self-bonding force. Moreover, in said invention, the density of the product is substantially same throughout the sheet. On the contrary, in the present invention, the density of the sheet is different in each portion, i.e. the highest density in the thinner portion, a higher density in the thicker portion, the original density in the portion of the original thickness.

On the other hand, a nonwoven fabric is described in U.S. Patent No. 3,240,657, wherein starting from a card web, a pattern of tubercles and holes disposed uniformly over the surface is imparted to the fabric by using a patterning apparatus. In this patent, the strength of the sheet is based on the binding force of a binder, as described in its Examples 1 and 2. It is clear that the said product differs from the product of the present invention wherein the component fibers are connected chemically to each other by a self-bonding force. Furthermore, the products described by the said patent,the density of the thinner portion is equal to that of the thicker portion, just as in the above-mentioned

U.S, Patent No. 2,771,363.

U.S. Patents Nos. 3,081,514 and 3,081,515 cover a product, a foraminous nonwoven fabric. These two patents are directed to nearly the same subject matter. In these patent products, the fabric comprises a multiplicity of yarn-like fiber groups, the fibers constituting the groups being substantially parallel. Moreover, the fibers in said fabric are defined as being in mechanical equilibrium and fiber segments thereof at each juncture being in mechanical engagement.

In German Patent Specification No. 617,804, a fiber sheet is passed through between press rolls together with an endless band on the surface of which a number of projections is arranged, and a product with indentations is obtained.

In German Patent Specification No. 194,490 a fiber sheet is pressed with a deeply etched patterning roll, and a product with projections and indentations is obtained.

Furthermore, in U.S. Patent Specification No. 2,146,871, a fiber sheet is pressed with a plate in which a nmmber of apertures is arranged and a product with projections is obtained.

In the products of these patent processes, the density and the thickness are different between pressed regions and non-pressed regions same as the product of the present invention. However, in those processes, the displacement of fibers, and accordingly, the differentiation of fiber quantity per unit area do not occur, because the patterning is applied at a relatively low water-containing value.

On the other hand, in the present process, the wet sheet is compressed directly between a pair of press rolls, and the displacement of fibers occur by such compression. Because,

the displacement of the fibers by mere compression is possible only at a water-containing Value of from 600 to 6,000% as described hereinbefore. As the result, in the present product, not only the differentiation of the thickness is occur, but also the fibers quantity per unit area is different in each region.

In U.S. Patent Specification No. 1,883,526, a pair of rolls, upper roll of which possesses a number of projections on its surface, is used for patterning. However, in said process, though a shaded pattern is imparted to the sheet by the displacement of a part of fibers in the sheet, the way of displacing the fibers is utterly different from that of the present process. In said process, the displacement of the fibers is done by the relative movement between the sheet and an upper design applying roll. For that purpose, the patterning rolls are set apart from each other. In such a patterning, the differentiation of density does not occur though the fibers quantity per unit area is different in each region. The differnece between the present product and that obtained by the said patent process is very clear.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A process for manufacturing rayon paper or nonwoven fabric by a wet system, which includes the steps of dispersing in water staple fibers formed from incompletely regenerated cellulose filaments obtained by the viscose process, said filaments having a PSV of from 800 to 10,000%, forming a wet sheet from the resulting dispersion, said sheet having a WV of from 600 to 6,000%, and patterning the sheet by pressing it with a patterning means for imparting a difference in thickness across the paper arranged in a predetermined pattern on the surface.

2. A process according to claim 1, wherein the patterning means is a metal roll which possesses a number of projections arranged in a predetermined pattern on its surface.

3. A process according to claim 1, wherein the patterning means is a metal plate which possesses a number of projections arranged in a predetermined pattern on its surface.

4. A process according to claim 1, wherein the patterning means is a metal cylinder which possesses a number of punched holes arranged in a predetermined pattern on it.

5. A process according to claim 1, wherein the patterning means is a metal plate which possesses a number of punched holes arranged in a predetermined pattern on it.

6. A process according to claim 1, wherein the predetermined pattern is made of the combination of more than two shapes.

7. Patterned paper or the like made from incompletely regenerated viscose fibers, said product being patterned by a

A

Claim 7 continued:

patterning apparatus and being composed of the following three portions: first thin or foraminous areas having the highest density, second thicker areas having a relatively high density, and third areas of the original thickness having the original density less than the other areas, wherein the thinner areas form indentations and the thicker areas as well as the areas of the original thickness form projections in regard to the plane facing the patterning apparatus, said component fibers constituting the product being connected chemically to each other by a self-bonding force.

8. A product in accordance with claim 7, wherein the product is constituted by the following two portions: the first thinner or foraminous areas having a higher density and the second thicker areas having a lower density.

9. A product in accordance with claim 7 or 8, wherein the second areas are distributed in a matrix consisting of the first areas.

10. A product in accordance with claim 8, wherein the first areas are distributed in a matrix consisting of the second areas.

Fig 1

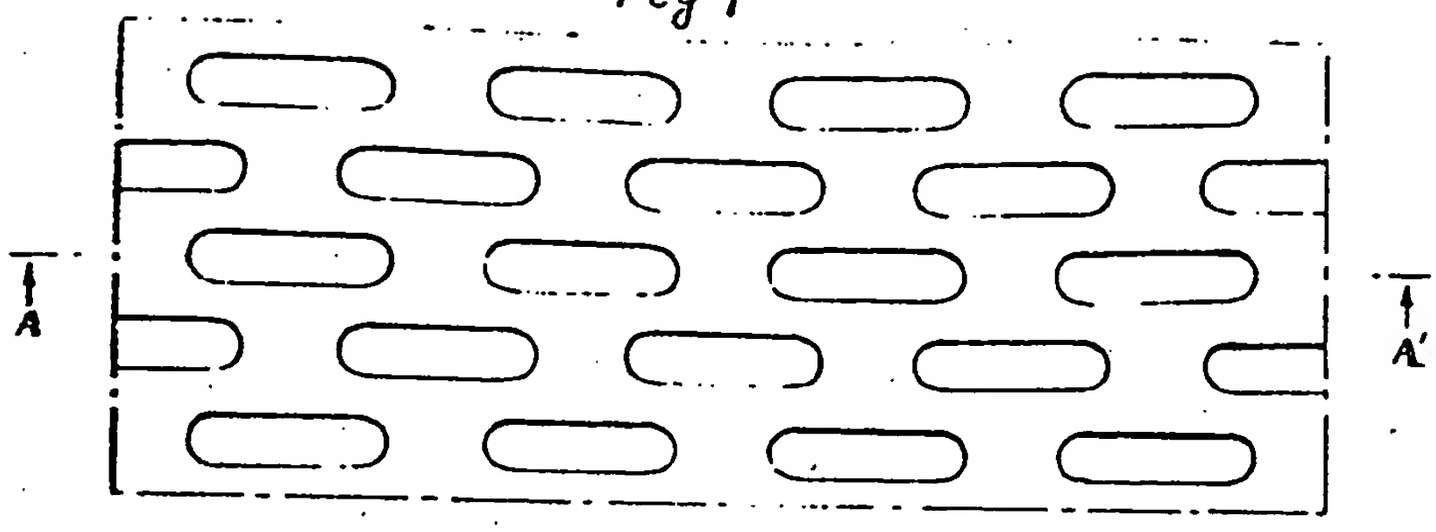

Fig 2

Fig 3

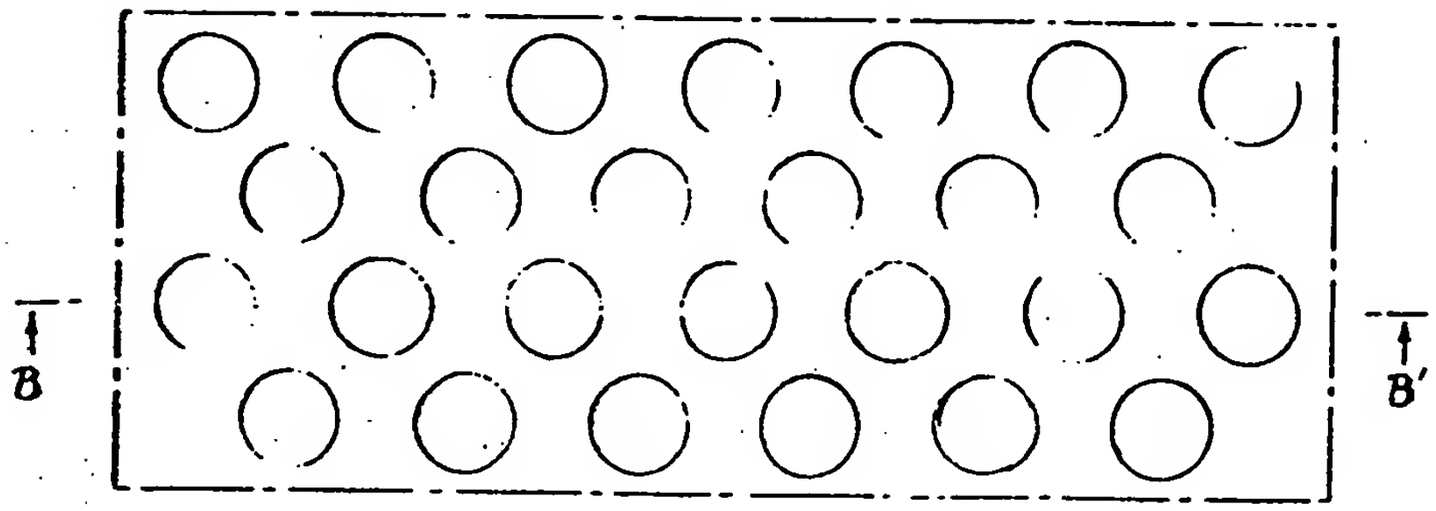

Fig 4

Fig 5

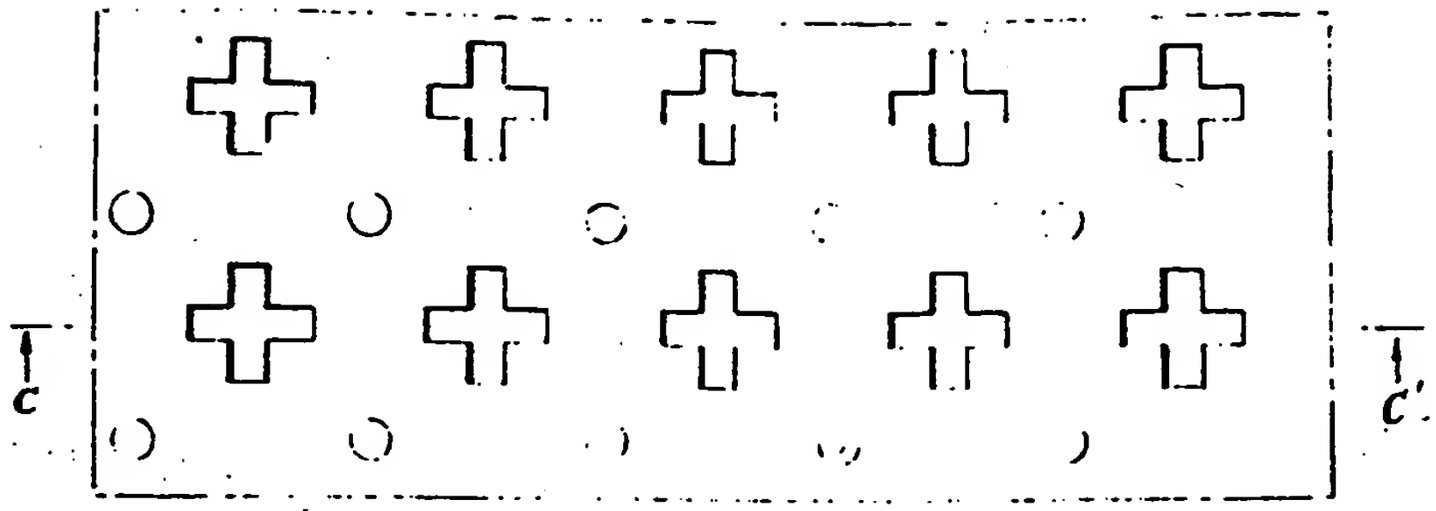

Fig 6

Fig 7

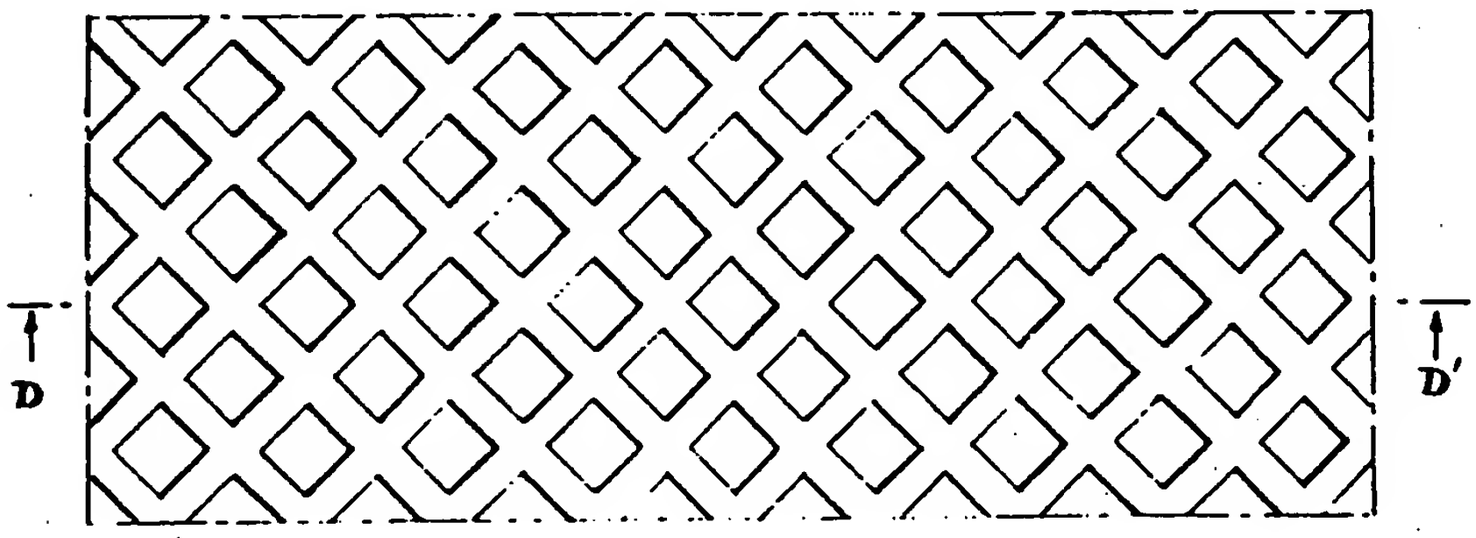

Fig 8

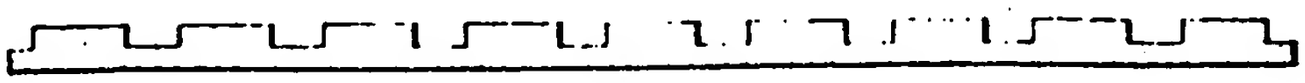

Fig 9

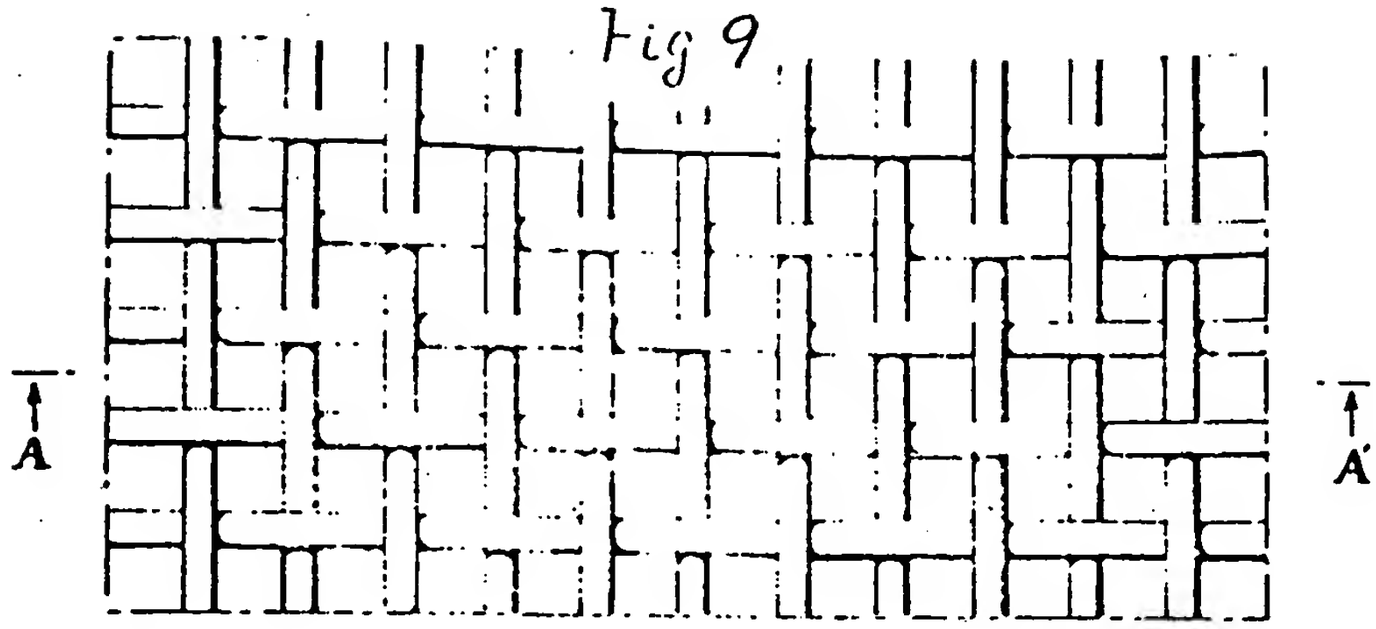

Fig 10

Fig 11

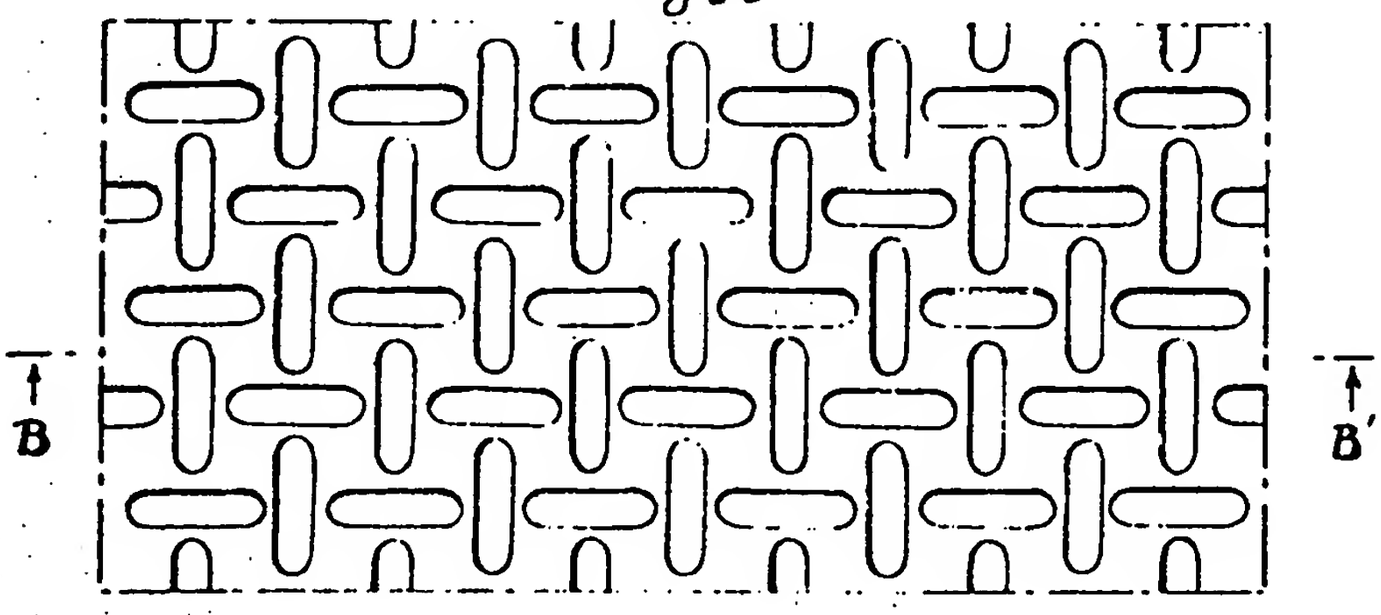

Fig 12

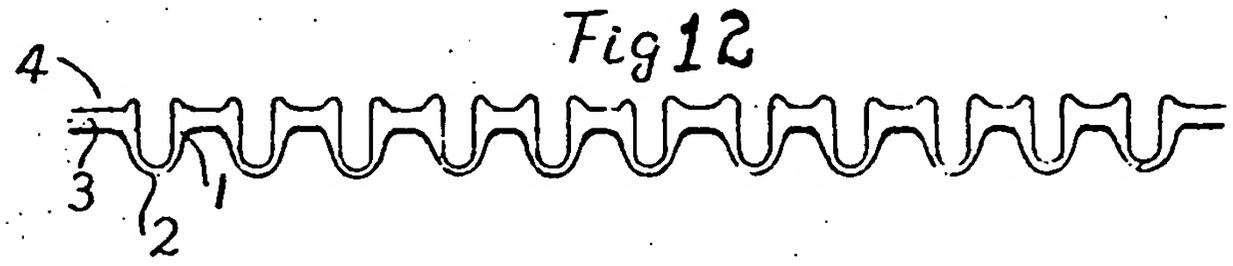

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Fig 13

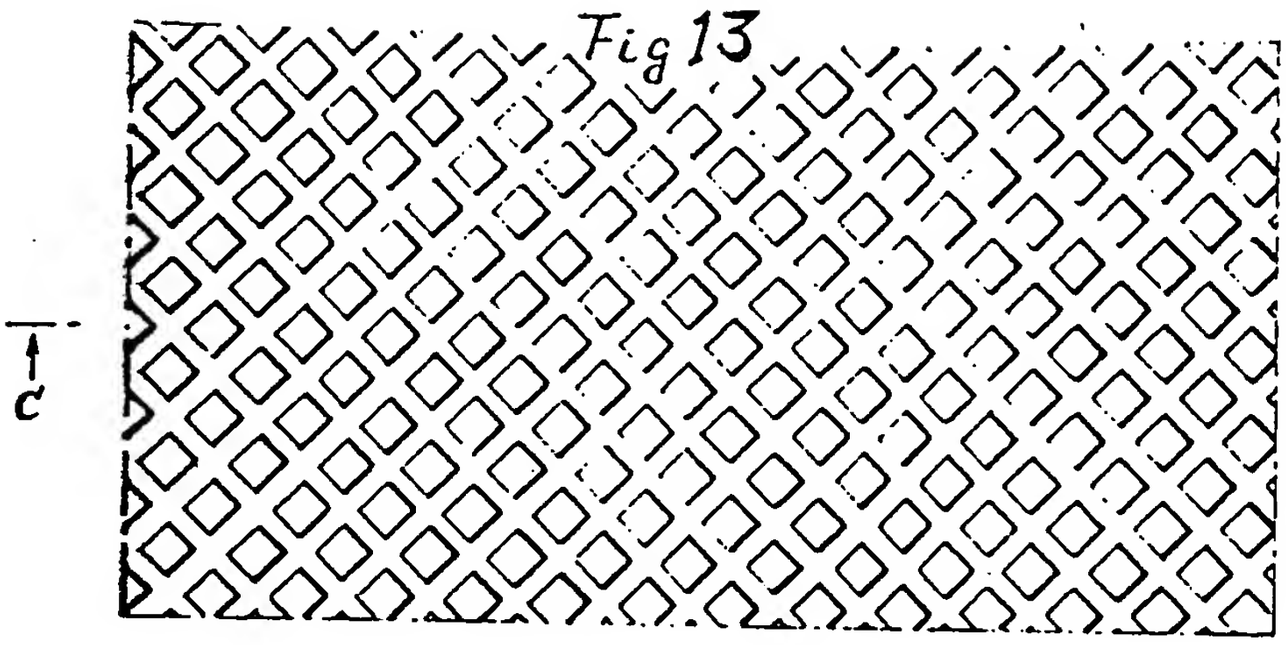

Fig 14

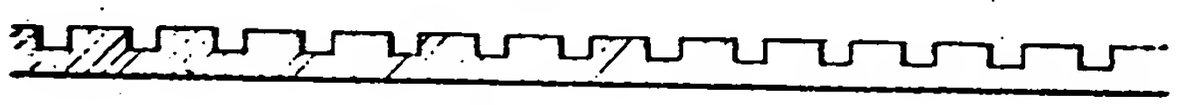

Fig 15

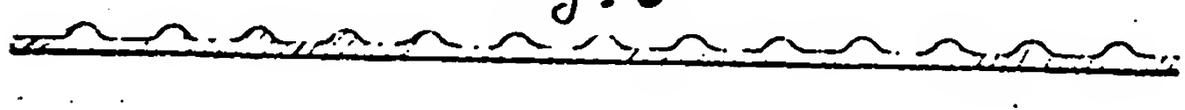

Fig 16